Freshwater Fish Group &
Fish Health Unit
Centre for Fish & Fisheries Research

Feral fish control activities in the South West Linkages Target Area

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Report to

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"Protecting threatened fishes in the South West Linkages Target Area"

Introduction

The southwest of Western Australia is a globally recognised hotspot of biodiversity and species endemism (Myers *et al*. 2000; Olson & Dinerstein 2002). The region houses a depauperate but highly endemic freshwater fish and decapod crustacean fauna, with >80% of the native fish species and 100% of the native decapod crustacean species occurring nowhere else on the planet (Morgan *et al*. 2011). A number of these species are naturally rare or have restricted distributional ranges and all species of the region face varying degrees of threat from various anthropogenic stressors including climate change, habitat destruction, pollution, river regulation, introduced species and water abstraction (Morgan *et al*. 2011). Consequently, a number of species are listed as vulnerable to extinction or near threatened under State and/or Federal legislation, while the most imperilled species, including the Hairy Marron and the Western Trout Minnow, are listed as critically endangered (Morgan *et al*. 2011).

One of the key threats to native biodiversity in fresh waters of the region comes from the introduction of alien species into the wild. Historically, fish species were introduced in the south-west to provide enhanced sport fishing opportunities (e.g. Rainbow Trout, Redfin Perch) or for biological control (e.g. Eastern Gambusia), but in the last 40 years the incidence of species introductions has soared mainly due to the illegal release of popular aquarium and aquaculture species (Beatty & Morgan 2013). Beatty and Morgan (2013) listed 13 alien fish species in natural waterways of the region, and at least three additional species have also been reported (Duffy *et al*. 2013; M. Snow, Department of Fisheries, Government of Western Australia, pers. comm.).

Alien species threaten natives through a number of processes including predation, competition for food and habitat, degradation of habitat, and introduction of diseases and parasites (Hambleton *et al*. 1996; Morgan *et al*. 2004; Lymbery *et al*. 2010; Beatty & Morgan 2013). Once established, introduced species are notoriously difficult to eradicate from the wild, with such species as Eastern Gambusia so adaptable to local conditions that it is unlikely they will ever be eradicated. However, some large-bodied species such as Goldfish have been controlled to some extent in some parts of the region such as the Vasse River (Morgan & Beatty 2007); although without ongoing control effort, population levels inevitably recover to pre-control levels (Beatty *et al*. 2014).

The current study aims to assess and address current and future threats faced by south-western Australian endemic freshwater fishes. One of the specific goals is to enhance aquatic ecosystem health and reduce threats to native aquatic fauna by undertaking targeted feral fish control at four strategic sites where eradication is deemed most likely to be feasible. The results of this component of the study are presented in this technical report.

Methods

Site selection

There was a requirement to select a total of four sites considered feasible for eradication (rather than control) of feral fishes, thus a shortlist was prepared of locations in the target area (i.e. Harvey River to Frankland River) known to historically house the large-bodied feral species (e.g. Goldfish, Carp) that have proven to be ideal eradication targets in the past in the south-west region. Lentic waterbodies smaller than 5ha make ideal sites because their confines permit more effective targeting of feral fishes with available fishing gear. Preference was also given for sites known to house Balston's Pygmy Perch (*Nannatherina balstoni*) which is the flagship species for the project.

However, a review of historical distributional records revealed very few sites where this fish occurs sympatrically with feral species (see Morgan *et al*. 1998; FFGFHU unpubl. data). Therefore, two lentic waterbodies in the lower Warren River catchment known to house Goldfish populations were selected (Figure 1), as they were located near the confluence of Dombakup Brook, the upper reaches of which has a historical record for *N. balstoni* (Morgan *et al*. 1998).

Brookfield estate on the outskirts of Margaret River township was also selected as feral fish control site (Figure 1) despite the fact that there are no records of *N. balstoni* in the Darch Brook catchment in which Brookfield is situated. However, the species does occur in the Margaret River catchment of which Darch Brook is a tributary; therefore this site was selected in response to a recent reporting of a Goldfish sighting by a member of the general public at Brookfield.

The final site was chosen in response to a report by staff at the Cape to Cape Catchments Group (CCG) of Eastern Gambusia (*Gambusia holbrooki*) in the upper Margaret River, an area believed to be free of feral fishes. Eastern Gambusia is not a large-bodied species and is notoriously difficult to eradicate from natural waterways once established, however, this site was deemed a priority for further investigation due to its significance as a key refuge for *N. balstoni* and other threatened species such as Western Mud Minnow (*Galaxiella munda*) and Hairy Marron (*Cherax tenuimanus*). Two permanent pools in the area (i.e. Rapids Pool, Canebrake Pool; Figure 1) were selected to be surveyed for feral fishes.

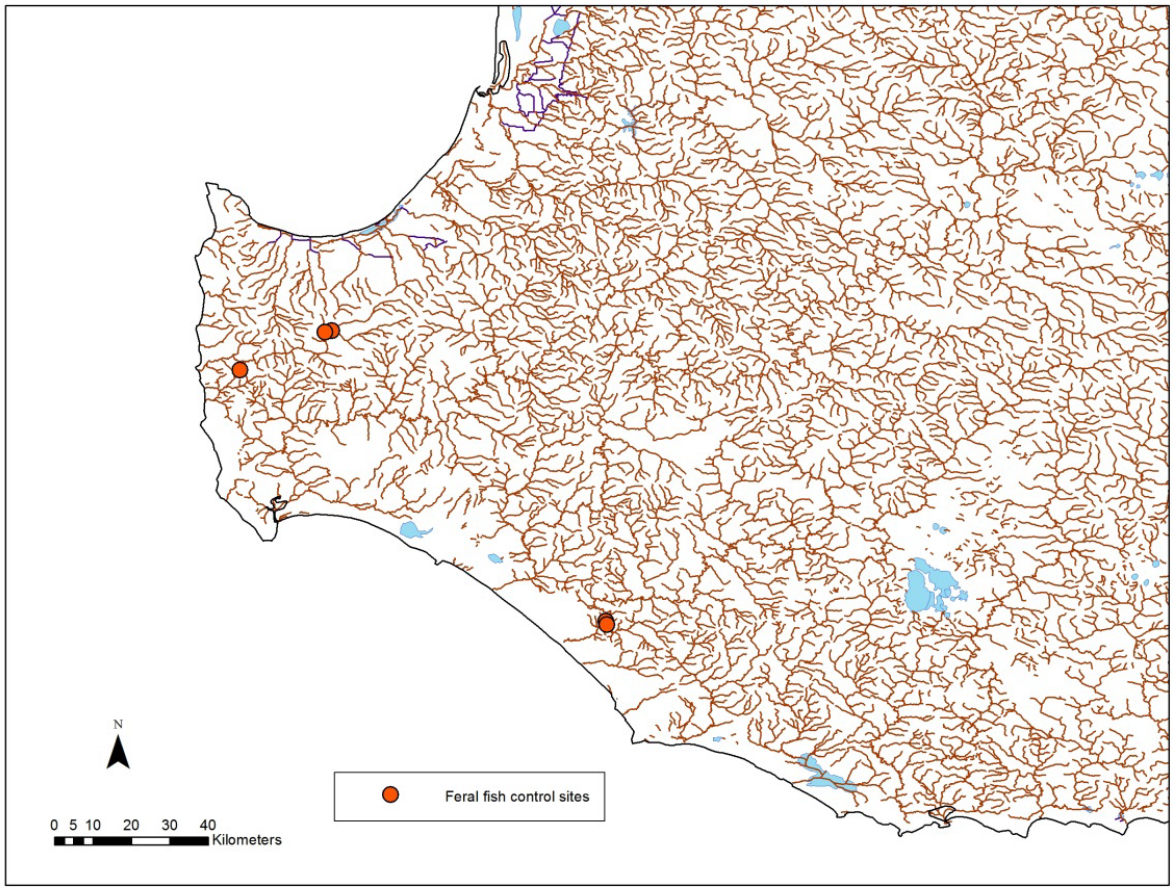

Figure 1. Sites selected for feral fish control events.

Capture techniques

Goldfish were targeted using boat and backpack mounted electrofisher (Smith Root VVP 15B and LR20), with two passes made around the perimeter and through the central portion of each targeted site. The electrofisher momentarily stuns fish allowing them to be captured at the surface with a long-handled scoop net. Juvenile fish were targeted using a 5m x 1.5m seine net constructed of 2mm woven mesh. All Goldfish captured were immediately euthanased in an ice slurry in accordance with the University's Animal Ethics permit.

Eastern Gambusia were targeted using a prototype, custom-made floating fyke net consisting of two 20m x 0.5m wings, a 0.8m x 0.5m opening, and a 2.5m long pocket with two funnels constructed from 2mm woven mesh. The net fishes to a depth of 0.5m and was designed to selectively target fishes such as Eastern Gambusia that prefer warmer water at the surface of waterbodies. A single observer (S. Beatty) also made a visual census of the upper Margaret River pools with mask and snorkel to check for the presence of any feral fishes that may have evaded capture in the floating fyke net.

Results and discussion

1. Natural billabong on lower Warren River (Box property)

Site description
This site consists of a natural permanent billabong situated adjacent to the main channel of the lower Warren River (Figure 2). During baseflow, the billabong holds approximately 4 ML of water. The waterhole becomes confluent with the main channel of the Warren River during winter peak flows, at which time its surface area and volume expands approximately five-fold.

Figure 2. Feral fish control site 1 - Natural billabong on the lower Warren River (Box property).

Background

The Freshwater Fish Group & Fish Health Unit (FFGFHU) first became aware of an infestation of Goldfish at this site in 2008 after the owners of the property (Don and Joanna Box) notified the Warren Catchments Council. Boat electrofishing was used to remove 40 individual Goldfish from the site on July 4 2008. A follow up eradication effort took place on May 5 2009 utilising seine net, gill nets, fyke nets and boat electrofisher which resulted in the capture and removal of 434 Goldfish and 343 Redfin Perch (*Perca fluviatilis*). It was estimated that 50% of the Goldfish observed during boat electrofishing activities evaded capture and removal.

The following month, between June 8-11 2009, the billabong was dewatered using a 6 inch diesel powered pump and fyke nets were placed at the outflow of the pump in the adjacent Warren River mainstem. Approximately 220 Redfin Perch and 30 Eastern Gambusia were captured in these nets and removed from the system. Reduced water levels following pumping resulted in a land bridge being exposed in the middle of the billabong, separating it into two shallow (depth ~0.3m) pools with a total surface area of approximately 450m^2 (Figure 3). Fourteen kilograms of the ichthyocide rotenone was mixed with water and applied to the pools in order to dispatch the remaining feral fishes. This resulted in a further ~500 individual Redfin Perch and 227 Goldfish being captured and removed from the system.

Figure 3. Feral fish control event conducted at the Box property on the lower Warren River in June 2009, involving dewatering of the habitat using an industrial sized pump and an application of the ichthyocide rotenone.

Current project

Despite the feral fish population at this site being eradicated in 2009, we decided to revisit the site as part of the current project in light of the fact that winter flows cause the billabong to connect to the Warren River in most years, thus allowing the possibility of recolonisation of feral fishes from the mainstem. Unfortunately, a delay in the granting of access to visit the nearby site on the Hayes property (see site 2 below) resulted in the feral fish control activities taking place during a period of high water levels in the lower Warren catchment. Such conditions are not conducive to effective utilisation of the boat electrofisher, but nonetheless, an area of ~4.8ha was fished and a solitary Goldfish specimen was captured and removed from the site on 8 July 2014 (Figures 4,5).

Figure 4. Boat electrofishing at the Box property site on the lower Warren River resulted in the capture of a solitary Goldfish individual.

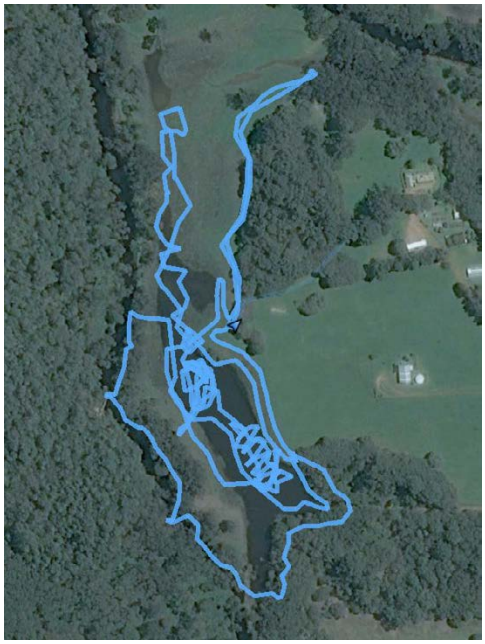

Figure 5. GPS track of electrofishing effort on Box property July 8 2014.

2. Natural billabong on lower Warren River (Hayes property)

Background

We were told of the existence of a natural billabong at this site by the owners of the nearby Box property in 2009. Given the similarity of this habitat and its proximity to the Box property, it was assumed that this site would be similarly infested with these feral fish species. Unfortunately, a lack of funding at the time prevented us from visiting the site to confirm this assumption. During the initial planning phase of the current project, we decided to include this site in order to confirm our assumptions of five years prior.

Current project

When approaching the owners of the Box property for permission to visit their site as part of the current project, we requested the contact details of this previously unvisited private property and were given the details of the current landholders (Sean & Kelsey Hayes) who were contacted shortly thereafter. Mr Hayes informed us that he had caught many Redfin Perch from the billabong himself since acquiring the property two years prior, and had also observed a school of large fish that he referred to as "Carp". He was highly supportive of our proposal to electrofish the billabong on their property, but under the proviso that he be present on site at the time. We were happy to oblige his request, but this, unfortunately led to a delay in access to the site as he and his wife are absentee landholders and only visit the property periodically. The delay resulted in us visiting the site after winter flows had commenced and water levels were higher than ideal for targeting feral fishes. However, despite the adverse water levels, we boat electrofished an area of ~2.1ha (Figure 6) and confirmed the presence of Goldfish at the site, with a single specimen captured (Figure 7).

Figure 6. GPS track of electrofishing effort on Hayes property July 9 2014.

Figure 7. Boat launch site on the banks of an inundated natural billabong in the lower Warren River catchment on the Hayes property (left); a solitary Goldfish individual was captured and removed from this site (right).

3. Brookfield estate, artificial ponds on a tributary of Darch Brook (Margaret River catchment)

Background

The FFGFHU has conducted a number of intensive feral fish control efforts and monitoring surveys in the Brookfield housing estate south of the townsite of Margaret River over the past six years. This site contains a series of ponds that are connected via a creek line which flows into Darch Brook (Margaret River catchment) and houses populations of invasive feral aquatic species including Eastern Gambusia, Yabby, and formerly, Goldfish. During the period 2008–2009 a range of efforts were made to eradicate the Goldfish population from Brookfield Estate using various methods. These included hook and line during a "fish out" event involving volunteers organised by the Cape to Cape Catchment Group (CCG); repetitive seine netting; boat-based and backpack electrofishing; and draining of water from habitats followed by application of rotenone. These efforts were thought to have eradicated Goldfish from the artificial ponds.

In 2013 a follow-up survey was conducted at Brookfield Estate and other sites further downstream in the Darch Brook catchment, including in the Margaret Riever mainstem near the Darch Brook confluence. No Goldfish specimens were encountered at any of the sample sites, although Eastern Gambusia was abundant at most sites, and Yabbies were present in the creek and upper pond at Brookfield Estate. The fact that no Goldfish were captured or observed during this survey led us to believe that the species had been successfully eradicated from the system. However, early in 2014 we received a report from CCG that a member of the public had potentially observed a Goldfish in the Brookfield Estate, but this was not confirmed. Therefore, we decided to include this site in the current study so as to follow up on the reported sighting.

Current project

Two artificial ponds in the Brookfield housing where Goldfish were previously found to be abundant (i.e. prior to eradication efforts in 2009) were electrofished on October 22 2014. A total combined area of ~0.07ha was electrofished and an additional three replicate 5m seine net drags were conducted in the shallows of the larger pond resulting in the capture of ~1000 Eastern Gambusia and a solitary Yabby (Figures 8, 9). No Goldfish specimens were captured or observed during the course of feral fish control activities. Both ponds were thoroughly fished, therefore, it appears that the reported sighting of a Goldfish at the site earlier this year was probably erroneous.

Figure 8. GPS track of electrofishing effort at Brookfield estate site October 22 2014.

Figure 9. UPPER LEFT: Stephen Beatty and Mark Allen operate a boat-mounted electrofisher to target feral Goldfish in an artificial pond in the Brookfield estate near Margaret River. UPPER RIGHT: Mark Allen uses a backpack-mounted electrofisher to target feral fishes in an artificial pond at Brookfield. LOWER LEFT: Mark Allen and David Morgan inspect the catch from a seine net in an artificial pond in Brookfield estate. LOWER RIGHT: a native Western Minnow (*Galaxias occidentalis*, upper) and feral Eastern Gambusia (*Gambusia holbrooki*, lower) (right).

4. Rapids Pool and Canebrake Pool (Rapids Conservation Park Pool, upper Margaret River)

Background

This section of the Margaret River catchment is the last remaining stronghold of the CRITICALLY ENDANGERED Hairy Marron and is also home to other listed threatened species including Balston's Pygmy Perch and Western Mud Minnow. In a survey of the Margaret River by FFGFHU in 2003, all sites sampled in the forested upper catchment were free of feral fishes, with the exception of Rapids Pool which contained Eastern Gambusia. The pool, which at the time was not connected by flow to the river, was repeatedly seine netted until no further Eastern Gambusia were captured and all follow up fish surveys in the upper Margaret River since then have failed to detect the species. However, two separate reports of Eastern Gambusia observed in nearby Canebrake Pool earlier this year by members of the general public had us concerned that the species had re-established itself in the upper Margaret River, therefore we decided to include these sites for feral fish control activities as part of the current project.

Current project

A prototype floating fyke net (Figure 10), designed specifically to target fishes such Eastern Gambusia, that tend to swim at the surface of waterbodies, was deployed at Rapids Pool on the afternoon of October 22 2014 (Figure 11), and checked the following morning. A regular fyke net was also deployed in the main channel of Margaret River just upstream of Canebrake Pool (Figure 11) and checked the following morning. Only native species were captured in these nets. In addition, Rapids Pool and the main section of Canebrake Pool (combined area of both sites ~2ha) were snorkelled in order to conduct a visual fish census whilst searching for the presence of feral fishes; however, none was observed at either site. Therefore, it appears as though the reported occurrence of Eastern Gambusia at these sites was erroneous. We believe the feral species may have been mistaken for the native Western Mud Minnow, which is usually rare in rivers of south-western Australia, but which is reasonably common in the upper Margaret River. This fish is similar in size and shape and can often be seen in the shallows at the margins of waterbodies, much like Eastern Gambusia.

Figure 10. Stephen Beatty makes a visual census of Rapids Pool (upper Margaret River) to check for the presence of feral fishes; the custom-made floating fyke net designed to target Eastern Gambusia can be seen in the foreground.

Figure 11. Locations of fyke net deployments and GPS tracks of viusal census conducted to search for feral fishes at Rapids Pool (left) and Canebrake Pool (right) in the upper Margaret River on October 22 2014.

Evaluation and recommendations

The control activities of the current project have resulted in the removal of a relatively small number of feral fishes (Table 1). Only two Goldfish specimens were captured and removed from the lower Warren River sites, largely due to the difficulty associated with electrofishing in flowing conditions at high water levels. The presence of feral Goldfish at the previously unsurveyed Hayes property was not surprising, given the historical abundance of the species at the nearby Box property. The capture of a Goldfish at the Box property site was disappointing, in light of the intensity of eradication effort that took place there in 2009. Presumably, the Hayes property site and/or the Warren River main channel have acted as refuges for Goldfish to re-colonise the Box property site during flood events when the river connects to the nearby billabong. In order to make a more accurate assessment of the current level of Goldfish infestation at these sites, the FFGFHU intends to replicate the feral fish control efforts outlined in this report at both of the lower Warren River sites when flow and water levels recede close to baseflow conditions (date to be confirmed).

The remaining two sites were chosen primarily in response to reports received from CCG of certain feral fish species in areas where they were believed to have been eradicated in the past. The report of Eastern Gambusia in the upper Margaret River catchment (Rapids Conservation Park) was a cause for genuine concern, given the area's conservation significance. It was with much relief that our survey of two pools detected no feral fishes. This included a survey of Rapids Pool, from which a small population of Eastern Gambusia was eradicated about 10 years ago.

Similarly, we were very interested in investigating a recent report of a Goldfish sighting in the Brookfield estate, particularly as a comprehensive survey of that site and the surrounding Darch Brook catchment in 2013 failed to detect any Goldfish, leading us to believe an intensive control program in 2008-2009 had successfully eradicated the species from this system. We included this site as part of the current study in order to verify the recent sighting and, if true, to assess the level of infestation of the species and implement control efforts at the earliest possible opportunity. Fortunately, from a conservation perspective, this was not required as Goldfish were not found at the site. The site was infested with feral Eastern Gambusia and Yabbies, however, the eradication of these species is not usually feasible as they are both hardy and adaptable to local conditions. Yabbies are even capable of burrowing, and thus capable of even surviving extreme eradication methods such as habitat dewatering.

Future recommendations stemming from this component of the study include:

- Replicating control efforts at the two Warren River sites at near-baseflow water levels in order to ascertain the current level of Goldfish infestation in these two presumed refuges.

- Community and school education initiatives have proven enormously successful during the current study. We recommend that these initiatives be expanded to other parts of the region, and indeed elsewhere in the State, to get the message out there that when it comes to feral fishes, "prevention" of their introduction (or re-introduction) is much more effective than any "cure"in the form of control or eradication efforts. Unless there is a substantial increase in public awareness of the detrimental impact feral species have on native aquatic biodiversity, further introductions of exotic species by an apathetic or unaware general public are probably inevitable, as evidenced by the surge in fish introductions in southwestern WA over the past 30 years.

Table 1. Numbers of feral fishes and crayfishes removed at each control site during control/eradication events during the project.

(* denotes that a species was likely to be present in much higher numbers than indicated in capture data. -- denotes a species that was not expected to occur at a particular site)

				Number of individual feral fishes/crayfishes captured (observed)		
Site	**Latitude/ Longitude**	**Hectares fished**	**Method(s)**	Goldfish (*C. auratus*)	Eastern Gambusia (*G. holbrooki*)	Yabby (*C. destructor*)
1. Lower Warren billabong (Box property)	-34.558 115.940	~4.8	Boat electrofisher	1* (0)	0* (0)	--
2. Lower Warren billabong (Hayes property)	-34.565 115.943	~2.1	Boat electrofisher	1* (0)	0* (0)	--
3. Brookfield estate ponds (Darch Bk)	-33.969 115.082	~0.07	Boat & backpack electrofisher	0 (0)	1000 (~5000)	1 (4)
4. Rapids Pool & Canebrake Pool (Margaret River)	-33.877 115.301 -33.880 115.283	~2.0	Fyke nets, visual census	-- --	0 (0) 0 (0)	-- --

Acknowledgements

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